Claims

We claim:

1. A method for increasing transmit diversity gain in a wireless communication system including a transmitter with 2^N transmit antennas, where N is greater than one, and a receiver with one receive antenna, comprising:

generating, in the transmitter, a stream of pairs of symbols in a form X_1 and X_2;

space-time transmit diversity encoding each pair of symbols at a symbol-level stage to produce a 2^1 x 2^1 matrix

$$C=\begin{bmatrix} X_1 & X_2 \\ X_2^* & -X_1^* \end{bmatrix}$$ for each pair, where * denotes a complex conjugate;

and

space-time transmit diversity coding each pair of 2^1 x 2^1 matrices C of the previous state in a next stage at a block level to produce a 2^2 x 2^2 output matrix

$$T=\begin{bmatrix} C_1 & C_2 \\ C_2^* & -C_1^{*1} \end{bmatrix}=\begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ X_2^* & -X_1^* & X_4^* & -X_3^* \\ X_3^* & X_4^* & -X_1^* & -X_2^* \\ X_4 & -X_3 & -X_2 & X_2 \end{bmatrix};$$

feeding transmit symbols of the output matrix T, in a left-to-right order, of each row, in a top-to-bottom order, to a corresponding different transmit antennas.

2. The method of claim 1, further comprising:

applying a transmit weight to each transmit symbol before transmitting the transmit symbol.

3. The method of claim 2, in which the transmit weight is based on channel conditions.

4. The method of claim 3, in which the channel condition is estimated by the transmitter.

5. The method of claim 3, further comprising:

measuring the channel conditions in a receiver of the transmit symbols; and

feeding back the channel condition to the transmitter.

6. The method of claim 1, in which the transmit weights are identical.

7. The method of claim 1, in which a receiver has a plurality of receive antennas.

8. The method of claim 1, further comprising:

repeatedly space-time transmit diversity coding each pair of 2^{n-1} x 2^{n-1} matrices of the previous state n-1 in a next stage n at the block level to produce a 2^n x 2^n output matrix

$$T=\begin{bmatrix} C_1 & C_2 \\ C_2^* & -C_1^{*1} \end{bmatrix}=\begin{bmatrix} X_1 & X_2 & X_3 & X_4 \\ X_2^* & -X_1^* & X_4^* & -X_3^* \\ X_3^* & X_4^* & -X_1^* & -X_2^* \\ X_4 & -X_3 & -X_2 & X_2 \end{bmatrix},$$

until a number of rows in a final output matrix is equal to 2^N.

9. A wireless transmitter including2^N transmit antennas, where N is greater than one, comprising:

means for generating a stream of pairs of symbols in a form X_1 and X_2;

a space-time transmit diversity encoder configured to encode each pair of symbols at a symbol-level stage to produce a 2^1 x 2^1 matrix

$C=\begin{bmatrix} X_1 & X_2 \\ X_2^* & -X_1^* \end{bmatrix}$, where * denotes a complex conjugate; and

a plurality of space-time transmit diversity encoders, connected serially, configured to encode each pair of 2^{n-1} x 2^{n-1} matrices of the previous state n-1 in a next stage n at a block level to produce a 2^n x 2^n output matrix; and

means for feeding transmit symbols of an output matrix of a last stage of the plurality of encoders, in a left-to-right order, of each row, in a top-to-bottom order, to a corresponding different one of 2^N transmit antennas.

10. A wireless transmitter, comprising:

2^N transmit antennas, where N is greater than one;

means for generating a stream of pairs of symbols;

one symbol level space-time transmit diversity encoder generating a first output matrix from each pair of symbols in the stream;

N-1 block level space-time transmit diversity encoders connected serially to each other and a first one of the block level space-time transmit diversity encoders is connected to the one symbol level space-time transmit diversity encoder, each block level space-time transmit diversity encoder generating a subsequent output matrix from pairs of output matrices of a previous encoder; and wherein a last encoder generates a 2^N x 2^N output matrix; and

feeding transmit symbols of the last output matrix, in a left-to-right order, of each of N rows, in a top-to-bottom order, to a corresponding different one of the 2^N transmit antennas.